South Hutchinson, KS

Technical Assistance Project

prepared for:

Kansas Department of Agriculture
Division of Water Resources

prepared by:

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List of Abbreviations

1D	1-Dimensional
AMC	Antecedent Moisture Condition
CN	Curve Number
EPA-SWMM	Environmental Protection Agency - Storm Water Management Model
FEMA	Federal Emergency Management Agency
GIS	Geographic Information Systems
GUI	Graphical User Interface
KDA	Kansas Department of Agriculture
LiDAR	Light Detection and Ranging
PC-SWMM	Personal Computer - Storm Water Management Model
SCS	Soil Conservation Service
TR-55	Technical Release - Number 55

1.0 Executive Summary

The Kansas Department of Agriculture (KDA) received funding from FEMA to complete a technical assistance project for the City of South Hutchinson, Kansas to investigate and present potential flood mitigation alternatives to reduce flooding issues in South Hutchinson, Kansas. There is no funding match requirement and no cost to the City of South Hutchinson for this project.

Wood was retained by KDA to provide Technical Assistance to the City of South Hutchinson. The recent interior drainage analyses from the levee certification project of the South Hutchinson Levee System indicates that the conveyance through the levee may not be able to adequately convey the 1% annual chance design storm especially during higher tailwater conditions from the Arkansas River. The floodplains from the levee certification project were preliminarily issued February 15th, 2020 and anticipated to be effective January 29th, 2021. These preliminary floodplains impact numerous existing buildings. Figure 1-1 shows the preliminary 1% annual chance floodplain.

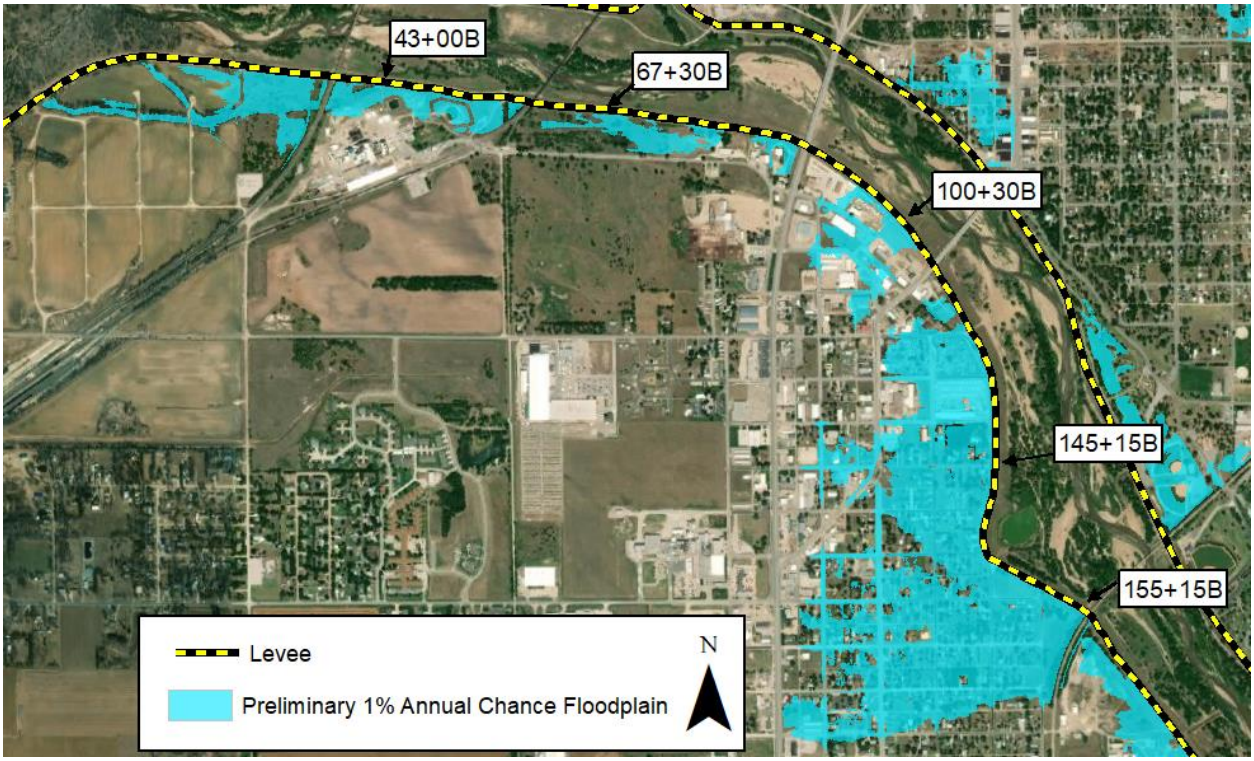


Figure 1-1: Preliminary 1% Annual Chance Floodplain

Sixteen alternative scenarios were originally identified as potential alternatives. Through collaboration with KDA and the City of South Hutchinson, three of these scenarios were

selected to estimate budget level cost for full design and construction. The three selected scenarios are described in Table 1-1.

Table 1-1: Summary of three options for budget level cost estimates.

	Summary of Improvements	Total Estimated Cost
Option 1	Detention at the levee and increased conveyance through the levee at levee station 100+30B	$527,040
Option 2	Five detention ponds inside the levee, along with improved conveyance through the levee at stations 145+15B and 155+15B	$15,216,800
Option 3	Detention at the levee and increased conveyance through the levee at levee station 145+15B and 155+15B	$3,430,400

Option 1 is independent to Option 2 and Option 3 and helps mitigate flood risk at levee station 100+30B. Option 2 and Option 3 attempt to reduce flooding at levee stations 145+15B and 155+15B, but these options are not necessarily alternatives to one another. Option 2 addresses headwater flooding caused by local runoff and addresses ponding adjacent to the levee, while Option 3 only addresses ponding adjacent to the levee.

The estimated number of buildings impacted by the 1% annual chance event for both existing conditions and proposed alternatives conditions is shown in Table 1-2. Buildings in Option 1 are independent to buildings in Option 2 and Option 3.

Table 1-2: Estimated number of buildings in the 1% annual chance event.

	Existing Conditions	Proposed Conditions
Option 1	5	0
Option 2	192	1
Option 3	192	3

Other options to consider are to do nothing or possibly buy out buildings affected by flooding. The Do-Nothing option would not help alleviate the flooding risk or the need to carry flood insurance and buying out buildings would come at significant cost to the City of South Hutchinson.

These options are not the only options to consider, but any option moving forward would need to be evaluated by the City of South Hutchinson as to whether it could adequately meet their needs, concerns, and budget capabilities.

2.0 Introduction

2.1 Purpose

The purpose of this project is to investigate and present potential flood mitigation alternatives to the Kansas Department of Agriculture and the City of South Hutchinson that address flood risk for the mapped 1% annual chance event in South Hutchinson, Kansas. The 1% annual chance floodplains were preliminarily issued February 15th, 2020 and anticipated to be effective January 29th, 2021.

2.2 Project Background

The Preliminary Floodplain Map for South Hutchinson includes 1% annual chance floodplains that were originally developed as a result of an interior drainage analyses from the levee certification project of the South Hutchinson Levee System. As required by FEMA, interior drainage areas must be mapped to represent the risk of flooding as a result of the levee system whether by conveyance capacity limitations or as a result of tailwater conditions from the Arkansas River. This can result in shallow ponding areas which would impact numerous existing buildings. Figure 2-1, which is the same as Figure 1-1 and Figure 3-1, depicts the preliminary 1% annual chance floodplain adjacent to the South Hutchinson Levee System.

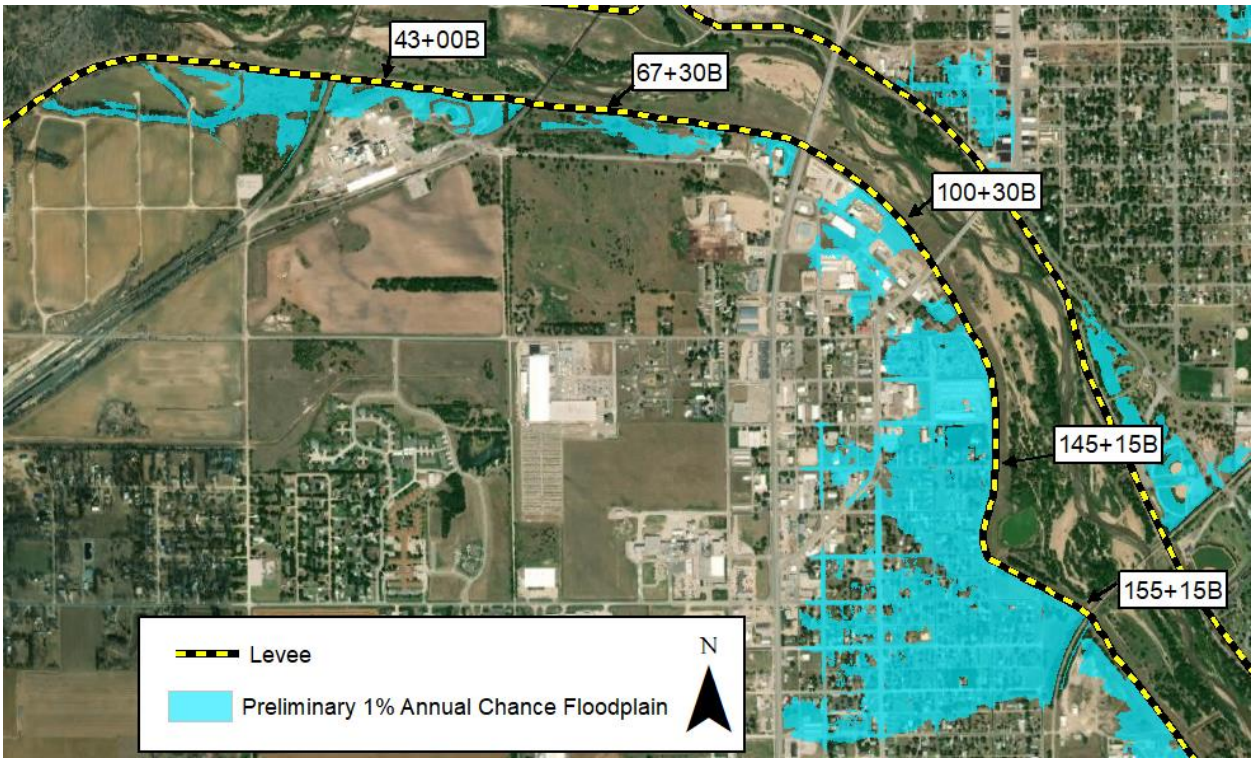


Figure 2-1: Preliminary 1% Annual Chance Floodplain

Given the potential flood risk, it was identified by key stakeholders of the City of South Hutchinson and Kansas Department of Agriculture (KDA) that a flood mitigation study would be beneficial to determine potential options for reducing flood risk concerns. The primary goal of this technical assistance project will be to identify potential cost effective mitigation improvements that could reduce the flood risk areas within the City of South Hutchinson (adjacent to the levee system from station 110+30B to 155+15B), without causing adverse impacts to the community.

3.0 Technical Engineering Methods

The following sections discuss the general engineering methods that were utilized for the Technical Assistance project.

3.1 Existing Conditions Preliminary FEMA Model

The existing conditions preliminary model for the City of South Hutchinson is a 1D EPA-SWMM 5 model that was developed using PC-SWMM GUI software. This preliminary floodplain is set to go effective January 29th, 2021. The EPA-SWMM 5 model was created to quantify ponding areas adjacent to the levee system utilizing a Coincident Frequency Analysis to calculate the flooding elevation on the interior of the levee structure based on a statistical riverine condition. This model is detailed enough to conceptually assess flooding and evaluate potential mitigation options.

3.2 Rainfall Data

To be consistent with the preliminary FEMA DFIRM model, rainfall depths used in all alternatives analysis matches the preliminary FEMA DFIRM model. These rainfall depths are listed in Table 3-1.

Table 3-1: Rainfall Depths used in the current effective model

Rainfall Event	Rainfall Depths (inches)
50% Annual Chance	3.12
20% Annual Chance	4.32
10% Annual Chance	4.80
2% Annual Chance	6.72
1% Annual Chance	7.44
0.2% Annual Chance	9.23

3.3 Transform (Runoff-Block Method)

EPA-SWMM hydrology uses the runoff block method to transform the rainfall to runoff. This method uses flow length, basin width, and basin slope to determine the shape of the runoff hydrograph. The flow length parameter is not an exact measurement but is used to approximate overland flow length and a fraction of sheet and shallow concentrated flow. The flow length was computed as the length of the longest flow path, using the

methods described in the NRCS TR-55. Flow width is automatically calculated by dividing subcatchment area by flow length. Basin slope was calculated for each basin from the LIDAR topography data.

Flow lengths from the existing conditions FEMA DFIRM models were used in all alternative's analysis unless subcatchment changes were made. If subcatchments were needing to be changed, then the previously described method of flow length was used to estimate flow length of the new subcatchment area.

Similarly, if subcatchment changes were necessary, then average subcatchment slope was recalculated and applied to the subcatchment.

3.4 Infiltration

The U.S. Department of Agriculture SCS CN Method was used to compute infiltration losses. The CN is a function of both hydrologic soil group and land use. The CN's computed as part of this study assume an AMC of II as it is representative of typical conditions, rather than the extremes of dry conditions AMC I or saturated conditions AMC III.

CN's used in the preliminary study were used since no major landuse changes have occurred in the study area, and the delineation of the drainage areas have not changed since the preliminary model was developed.

3.5 Hydrograph Routing & Hydraulics

The 1-D Saint-Venant's Dynamic Wave routing method was used to model open-channel flow, subsurface stormwater conveyance systems, surface runoff, and backwater. This method was used so that the models can properly estimate reverse flow in pipes, backwater flows, and open channel flows. The routing time step was set to 3 seconds with a variable time step of 0.5 seconds.

3.6 Tailwater Conditions

Tailwater conditions put on the model were calculated during the interior drainage analyses for the levee certification as part of the Coincident Frequency Analysis (CFA). The tailwater conditions from the CFA were determined through statistical analysis of gage flow data on the Arkansas River. The tailwater outfall elevations used in this analysis are listed in Table 3-2.

Table 3-2: Tailwater elevations used at each outfall location

Levee Outfall Station	Tailwater Elevation (ft NAVD 88)
43+00B	1528.87
67+30B	1525.94
100+30B	1522.35
145+15B	1519.70
155+15B	1518.75

3.7 Existing Conditions Flooding Concerns

The preliminary 1% annual chance floodplain, shown in Figure 3-1, which is the same as Figure 1-1 and Figure 2-1, will be used by FEMA to assess flood insurance rates on home and business owners affected by this floodplain and depicts those areas at risk of flooding for the 1% annual chance event.

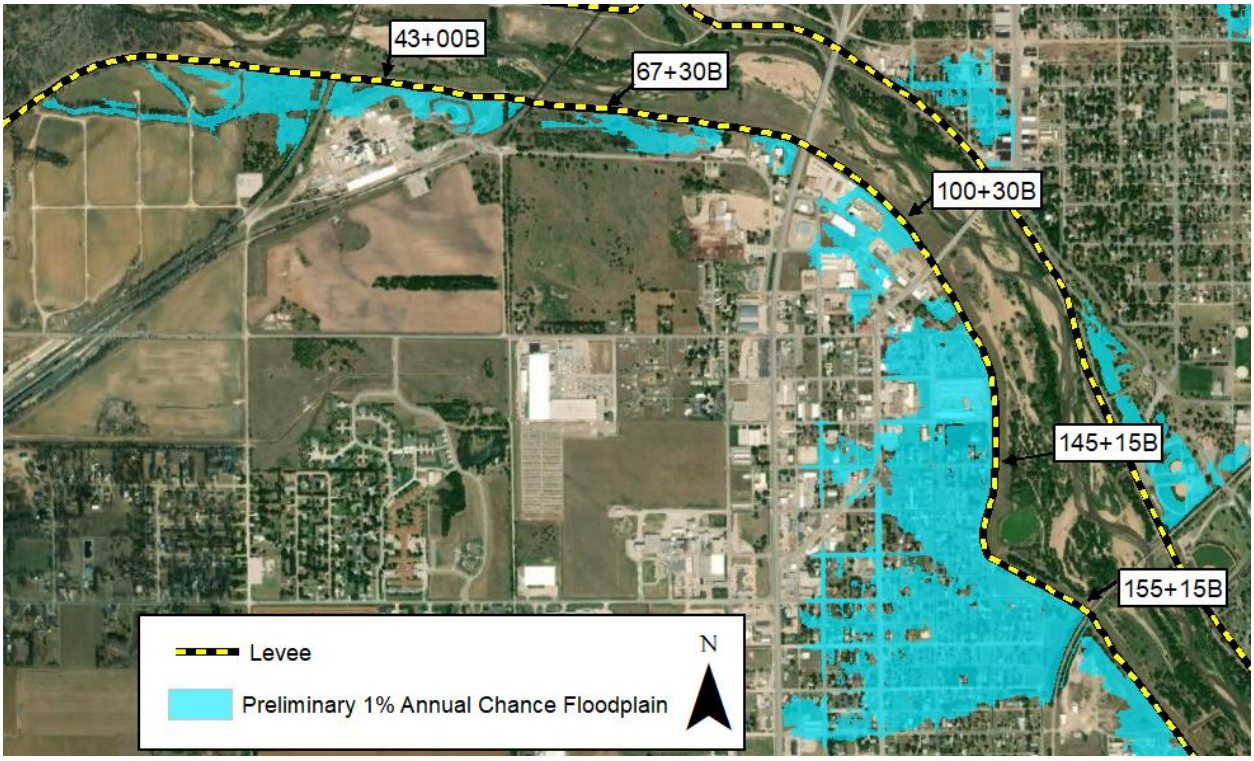


Figure 3-1: Existing Conditions 1% annual chance floodplain (same as Figure 2-1)

The preliminary 1% annual chance floodplain impacts approximately 197 buildings, with the majority of them being single family residences. Levee stations 155+15B, 145+15B, and 100+30B are the focus of this flood mitigation study since these are the locations where buildings are being impacted.

Though not required to be mapped, headwater is another concern, particularly at S Washington Street and E Avenue B. This is where the largest drainage area enters a stormwater system that runs the length of E Avenue B. The preliminary floodplain study model indicates that the stormwater system does not have the capacity to convey the 1% annual chance event. It predicts that water would back up near the baseball fields and overtop the roadway flowing towards/on S Main Street. This area of concern is shown in Figure 3-2.

Figure 3-2: Area of concern for headwater

4.0 Flood Risk Mitigation

4.1 Project Goals

Goals and objectives with clear metrics are key in identifying flood mitigation alternatives. These were collectively agreed upon by representatives of Wood, KDA, and the City of South Hutchinson and are listed below.

1. Remove as many buildings as possible from the 1% annual chance floodplain and ultimately reduce the risk of flooding to these properties.
2. Avoid proposing detention facilities or other structures on land identified for future development.
3. Minimize long-term and expensive maintenance costs.
4. Minimize buyouts.

4.2 Mitigation Options

Flood mitigation alternatives usually fall within 4 primary mitigation types; buy-out, individual structural improvements, stormwater system conveyance improvements, and detention and/or retention flood control improvements.

Buyouts are usually an option. In South Hutchinson there are approximately 197 buildings that are within the 1% annual chance floodplain and at risk. Approximately half of the town is included within the preliminary 1% annual chance floodplain. This option would not remove the areas from flood risk but instead remove buildings from the 1% annual chance floodplain and negating any associated damages. However, pursuing buyouts could have a significant economic and social impact to the City of South Hutchinson.

Another option would be to consider structural flood mitigation improvements. These options could include elevating buildings above the 1% annual chance water surface elevation, among many other activities. Again, approximately 197 buildings were identified to be at risk of flooding during the 1% annual chance storm event. This option would not lower the water surface elevations but would rather mitigate individual buildings from flood risk during a specific flood event (likely done for the 1% annual chance event).

Conveyance improvements are also a common mitigation practice. These types of improvement could include increasing the levee outfall capacity, increasing channel capacity, add pumping stations and building diversion structures. Several conveyance improvements were analyzed and are discussed in later sections of this report.

Detention and/or retention flood control structures are effective at reducing downstream peak discharges. Also, depending on the design, dry-detention basins with outlet control structures could be used to temporarily retain water volume, thus reducing both the peak discharge and volume of water at the levee outflow structures. Relatively small detention and/or retention flood control structures, like the ones proposed in this study, are often a cost-effective means for achieving flood mitigation because generally they are easy to construct. The downside is that detention/retention flood control facilities take up land which usually becomes undevelopable.

For this study, a combination of detention and conveyance improvements were considered and are discussed in detail within the following report sections.

4.3 Flood Risk Mitigation Alternative Analysis

4.3.1 Flood Risk Mitigation Process Overview

South Hutchinson has essentially three streamlines that convey water from upstream drainage areas to the levee outfall structures. For the purposes of this report they will be called flow lines. Those three flow lines are shown in Figure 4-1.

Figure 4-1: Three main flow lines conveying water to the levee.

Upstream detention was looked at first to detain the water before it could reach the levee. Upstream detention is complex in this area due to the high water table, limited space, and limited elevation grade. Six detention/retention ponds were modeled to capture headwater flows and lessen the impact of the peak flow reaching the levee system. All six ponds are shown in Figure 4-2, and were first modeled individually to assess the impact each detention/retention area provides. Combinations of these ponds were analyzed as well.

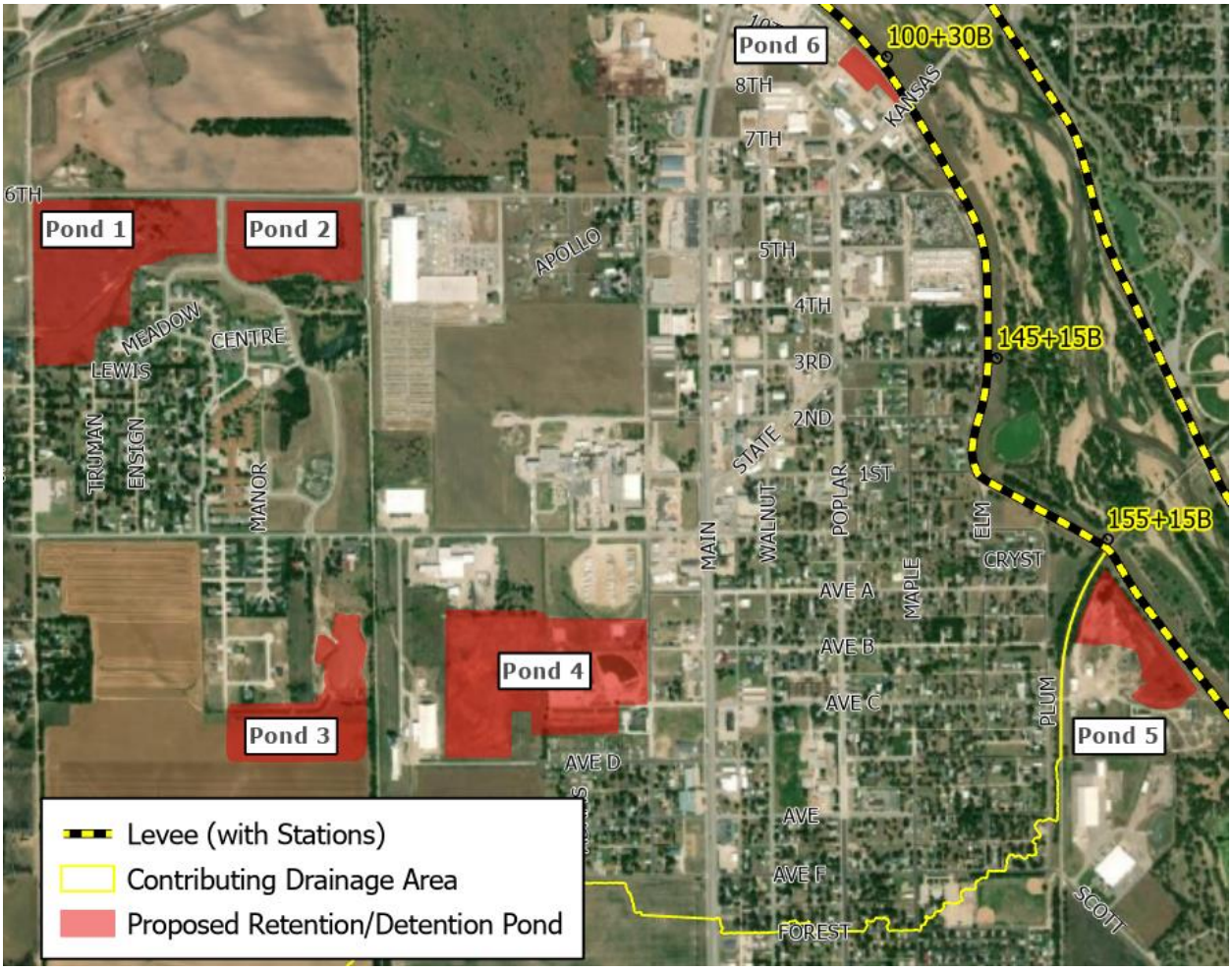


Figure 4-2: All six retention/detention areas developed

A further breakdown of each ponding area is described in the following sections.

4.3.2 Detention Ponds 1 and 2

The first detention areas considered were two inline retention ponds (Pond 1 and Pond 2) located South of W 6th Avenue and between N Valley Pride Road and the old railroad right-of-way, shown in Figure 4-3.

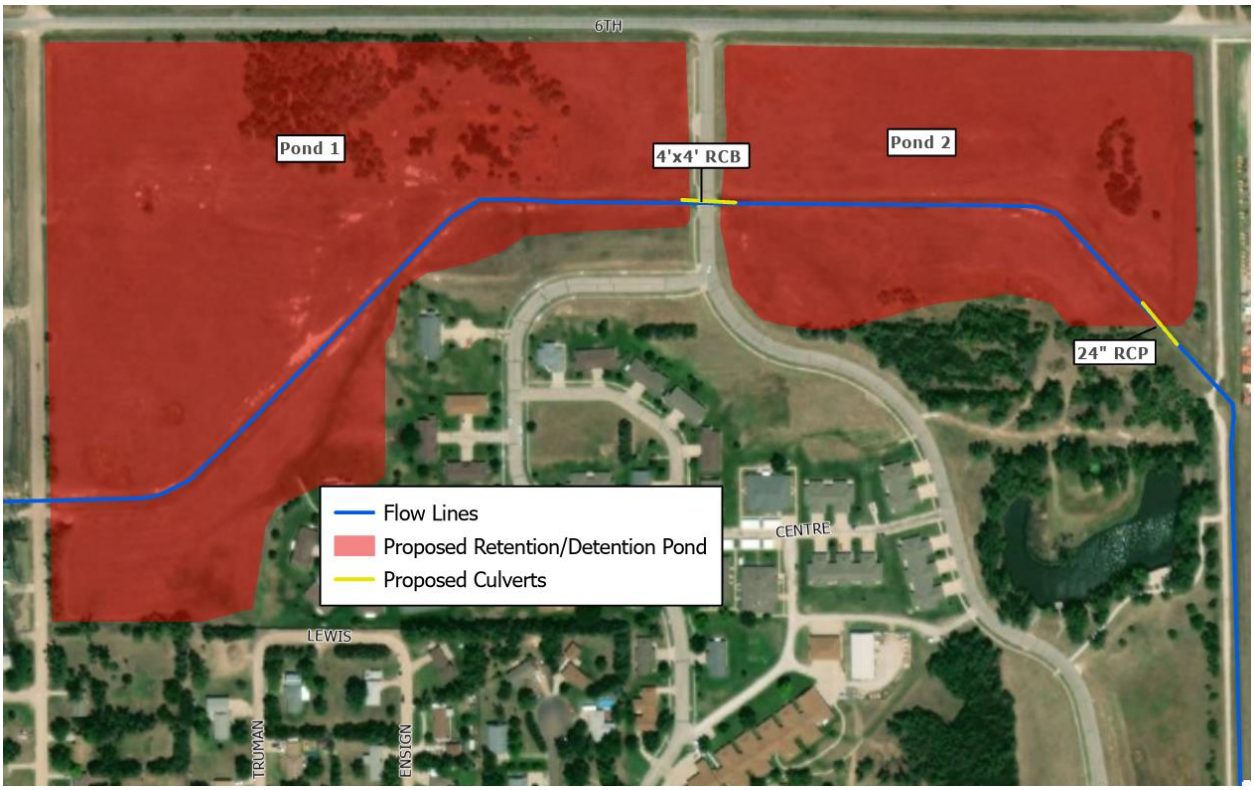


Figure 4-3: Detention Ponds 1 and 2.

Represented in Scenario 1 of Table 4-1, Pond 1 covers approximately 27.7 acres with a maximum depth of 3.5 feet and Pond 2 covers approximately 14.4 acres with a maximum depth of five feet. The conduits between the ponds under Friendship Road would need to be reduced from the existing 9′ X 4′ reinforced concrete box down to a 4′ X 4′ reinforced concrete box to take advantage of more storage in Pond 1. Currently, an open channel carries water downstream from the Pond 2 area. This open channel would need to be reduced to a 24″ reinforced concrete pipe with a 12″ orifice opening on the pipe.

4.3.3 Retention/Detention Pond 3

Another option for retention/detention is to add on to the existing pond located South of W Blanchard Avenue and just west of the old railroad right-of-way, shown in Figure 4-4.

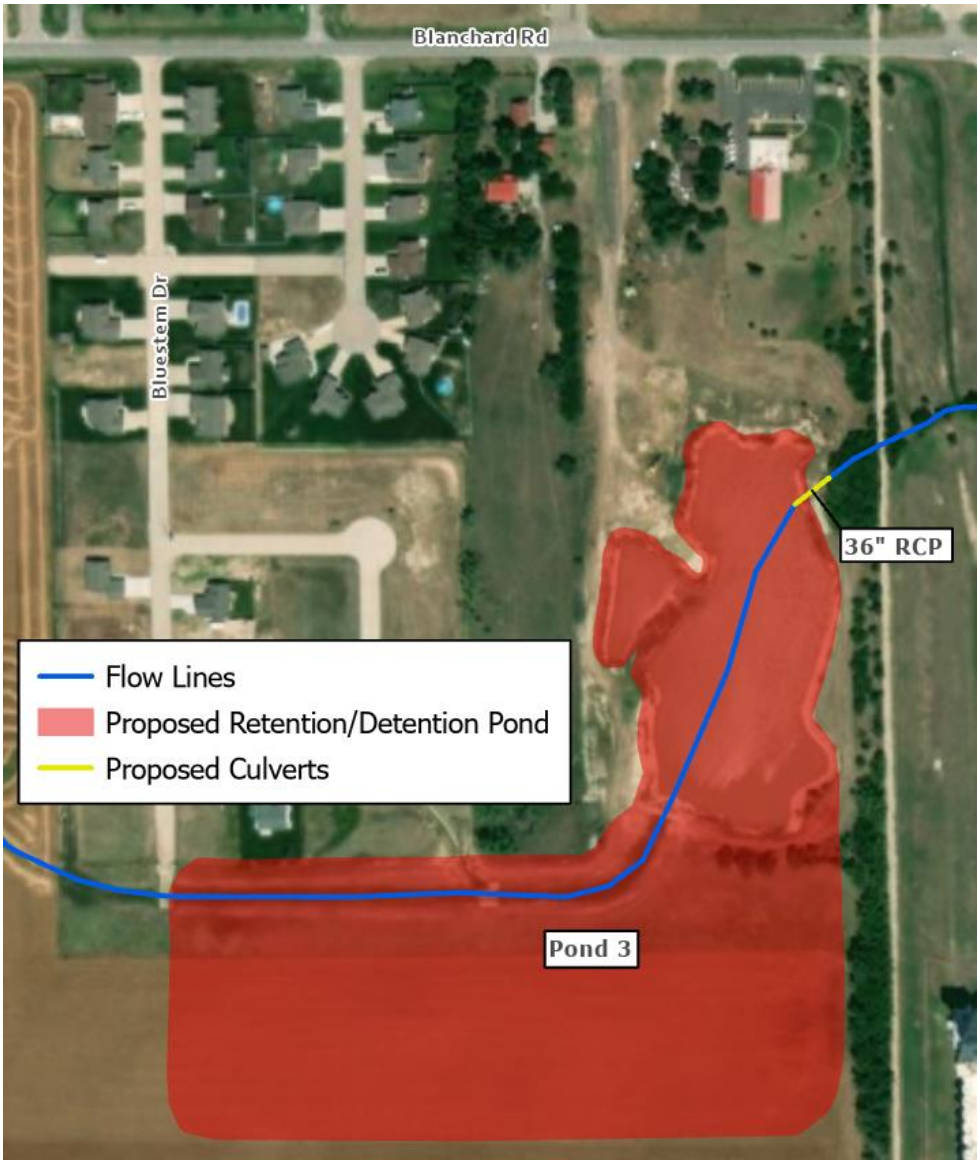


Figure 4-4: Retention/Detention Pond 3

Represented in Scenario 7 of Table 4-1, the additional area for Pond 3 covers approximately 11.3 acres with a maximum depth of six feet. This 11.3 acres is in addition to the pond that already exists there. A new outfall structure would need to be built that allows low flows to exit through a 36" reinforced concrete pipe keeping the ponded water at a lower pool elevation.

4.3.4 Detention Pond 4

Another option for detention would be to remove the baseball fields south of W Blanchard Avenue and just west of S Washington Street and regrading this area to allow for more detention. This option was proposed by officials from the City of South Hutchinson. The proposed area is shown in Figure 4-5.

Figure 4-5: Detention Pond 4

This pond is represented in Scenario 2 of Table 4-1. The pond is approximately 34.5 acres with a maximum depth of 2.5 feet. This area has limited slope to work with and allows for a limited pond depth due to the need for maintaining low flows out of the system coupled with shallow groundwater. This area is a meeting point for two flow lines to converge and enter a storm water pipe under W Avenue B and would not require any conduit construction/modification.

4.3.5 Detention Pond 5

There is limited available space for a detention pond adjacent to the levee system. Near levee station 155+15B, water can flow south under the railroad but it is relatively restrictive. Due to limited space on the northwest side of the railroad, Pond 5 was proposed on the southeast side of the railroad near levee station 155+15B, shown in Figure 4-6.

Figure 4-6: Detention Pond 5

Pond 5 covers approximately nine acres with a maximum depth of five feet. This detention pond is intended to capture some of the peak flow and allow it to be released out of the pond more slowly over time. Water is already conveyed under the railroad, but due to the size, type, and elevation of those conduits, flow under the railroad is limited. For Pond 5 to be fully utilized, conveyance under the railroad would need to be increased requiring coordination with the railroad, which can be difficult. The size of the increased conduits should either be two 48" or two 60" reinforced concrete pipes depending on the amount of improvements implemented upstream. The land for Pond 5 is already owned by the City of South Hutchinson.

Being adjacent to the levee, Pond 5 will need to have a seepage analysis done to ensure that there would not be seepage issues, particularly undercutting during high events on the Arkansas River. The invert of Pond 5 may need to be adjusted based on the seepage analysis, but expansion of the pond's footprint could accommodate any reduction of pond volume resulting from a change in pond invert elevation.

4.3.6 Detention Pond 6

Detention Pond 6 is adjacent to the levee near levee station 100+30B, shown in Figure 4-7. This area is independent of any other improvements.

Figure 4-7: Detention Pond 6

Pond 6, represented in Scenario 8 of Table 4-1, covers approximately 1.8 acres with a maximum depth of two feet. The pond alone does not make a large enough impact lower the 1% annual chance water surface elevation from the impacted buildings, but the pond paired with increased conveyance through the levee does lower the 1% annual chance water surface elevation from the impacted buildings that are located adjacent to levee station 100+30B. These conveyance improvements are estimated to be two 48" reinforced concrete pipes with flap gates. Increasing the conveyance would allow the high flows to enter the Arkansas River more quickly when the river is down, and the pond helps to contain the low flows when the river is up.

Again, a seepage analysis will need to be done on this storage area due to its proximity to the levee. Increasing the footprint of the pond could be difficult due to space restrictions but should not be considered impossible.

4.3.7 Levee Conveyance Improvements

Increasing conveyance proved to create the greatest reduction to the size of the 1% annual chance floodplain. The Coincident Frequency Analysis of the Levee Certification Project indicate that there is a low probability that the levee outfall locations at 100+30B, 145+15B, and 155+15B would simultaneously be impacted by a 1% annual chance tailwater condition coupled with a 1% annual chance headwater rainfall event. The interior drainage system of the City of South Hutchinson is considered probabilistically independent of the Arkansas River flooding events. Therefore, when considering flood risk mitigation, a combination of flooding modes should be considered, including a 1% annual chance rainfall event on the interior drainage system with a lower frequency flood event on the Arkansas River while also considering a smaller rainfall event on the interior drainage system with a higher 1% annual chance tailwater water elevation. The combination of these flood risk modes is important to ensure that flood risk mitigation alternatives do not result in adverse impacts.

4.4 Final Conveyance Improvement Scenarios

The multiple flood mitigation alternatives were grouped into scenarios which may contain several mitigation options. The scenarios were compared mainly on their ability to reduce the number of buildings impacted by the 1% annual chance floodplain, but also on their ability to reduce impacts of unmapped headwater flood risk. An overview of each scenario and a summary of conclusions for each scenario is shown in Table 4-1.

Table 4-1: Overview of Alternative Scenarios

Scenario #	Scenario Details	Scenario Conclusion
0	Base Model with existing conditions. Model duplicate to model from the Interior Drainage Analysis on the levee.	-
1	Add two retention/detention ponds along 6th Street. Resizing culverts under Friendship Road and restricting flow south toward W Blanchard Road. (Ponds 1 and 2)	Controls some headwater and lowers ponded elevation on the interior at levee station 155+15B but does not significantly reduce size of the 1% annual chance floodplain.
2	Removing the baseball fields at W Ave C and S Washington Street and regrading to allow for retention/detention (Pond 4)	Controls some headwater and lowers ponded elevation on the interior at levee station 155+15B but does not significantly reduce size of the1% annual chance floodplain.
3	Creating retention/detention southeast of the Railroad near levee station 155+15B. Also improving conveyance under the railroad and through the levee on the southeast side of the Railroad. (Pond 5)	Significantly reduces the size of the 1% annual chance floodplain at levee station 155+15B. Biggest improvement is due to increased conveyance through the levee. Also, lowered flooding elevation at levee station145+15B for the 1% annual chance floodplain, but not significantly. Does not address headwater issues.
4	Combination of Scenario 1 and Scenario 2	Controls some headwater and lowers flooding elevation at levee station 155+15B but does not significantly reduce size of the1% annual chance floodplain.
5	Combination of Scenario 1, Scenario 2, and Scenario 3	Greatly reduces the size of the 1% annual chance floodplain along the levee at stations 155+15B and 145+15B. Removes nearly all

		buildings from the 1% annual change floodplain. Reduces some headwater concerns but does not eliminate the headwater overtopping the roadway at W Avenue B and S Washington Street.
6	Scenario 3 with a pump station	Pump sizing necessary is large and costly.
7	Increase the retention/detention of the pond south of W Blanchard Street and half mile west of S Washington Street (Pond 3)	Controls some headwater and lowers water surface elevation on the interior at levee station 155+15B, but does not significantly reduce headwater concerns nor size of the 1% annual chance floodplain.
8	Existing conditions with retention/detention created at levee station 100+30B along with increased conveyance through the levee. This area is independent of flooding at 155+15B or 145+15B. (Pond 6)	Lowers the 1% annual chance elevation from all buildings adjacent to levee station 100+30B. Biggest improvement is due to conveyance through the levee.
9	Combination of Scenario 1, Scenario 2, and Scenario 7	Controls headwater and lowers water surface elevation on the interior at levee station 155+15B.
10	Scenario 3 with increased conveyance at 145+15B	Greatly reduces flooding along the levee at stations 155+15B and 145+15B. Does not address headwater concerns.
11	Combination of Scenario 1, Scenario 2, Scenario 7, and Scenario 3 with reduced conduit sizing under the railroad and through the levee in Scenario 3.	Greatly reduces the flooding along the levee at stations 155+15B and 145+15B and addresses headwater concerns.

12	Scenario 11 with Scenario 6 pumps	Even with the improvements in Scenario 11, pump sizing and costs are high.
13	Increased conveyance through the levee at levee station 155+15B	Significantly reduces flooding at levee station155+15B, reduces flooding at levee station 145+15B but only slightly. Does not address headwater concerns.
14	Scenario 11 with increased conveyance through the levee at levee station 145+15B	Greatly reduces the flooding along the levee at stations 155+15B and 145+15B, addresses headwater concerns by significantly limiting water that overtops 8th and Washington. Nearly all buildings would be removed from the 1% annual chance floodplain.
15	Scenario 13 with Scenario 3 with reduced conduit sizing under the railroad.	Significantly reduces flooding at levee station 155+15B, reduces flooding at levee station 145+15B but only slightly. Does not address headwater concerns.
16	Scenario 15 with increased conveyance through the levee at levee station 145+15B	Significantly reduces flooding at levee station155+15B, also significantly reduces flooding at levee station 145+15B for the 1% annual chance event but does not address headwater concerns.

4.5 Flood Mitigation Alternative Impacts

As stated, the primary goal of this project is to reduce the number of buildings in the 1% annual chance floodplain. The number of buildings removed from the 1% annual chance floodplain based on each scenario was tallied using GIS processes and tabulated in Table 4-2. Nine of the Scenarios resulted in over 170 homes removed from the 1% annual chance floodplain.

Table 4-2: Number of Buildings removed from the 1% annual chance floodplain

Scenario #	Total number of buildings removed from the 1% annual chance floodplain
0	0
1	56
2	69
3	171
4	95
5	186
6	113
7	71
8	5
9	168
10	188
11	186
12	186
13	171
14	191
15	171
16	189

4.6 Other Mitigation Considerations

4.6.1 Diversion Considerations

An early consideration was the possibility of conveying water to the north and diverting water that would normally reach levee station 145+15B. The water was to be diverted near W 6th Avenue and Whiteside Street and routed to levee station 67+30B, shown in Figure 4-8.

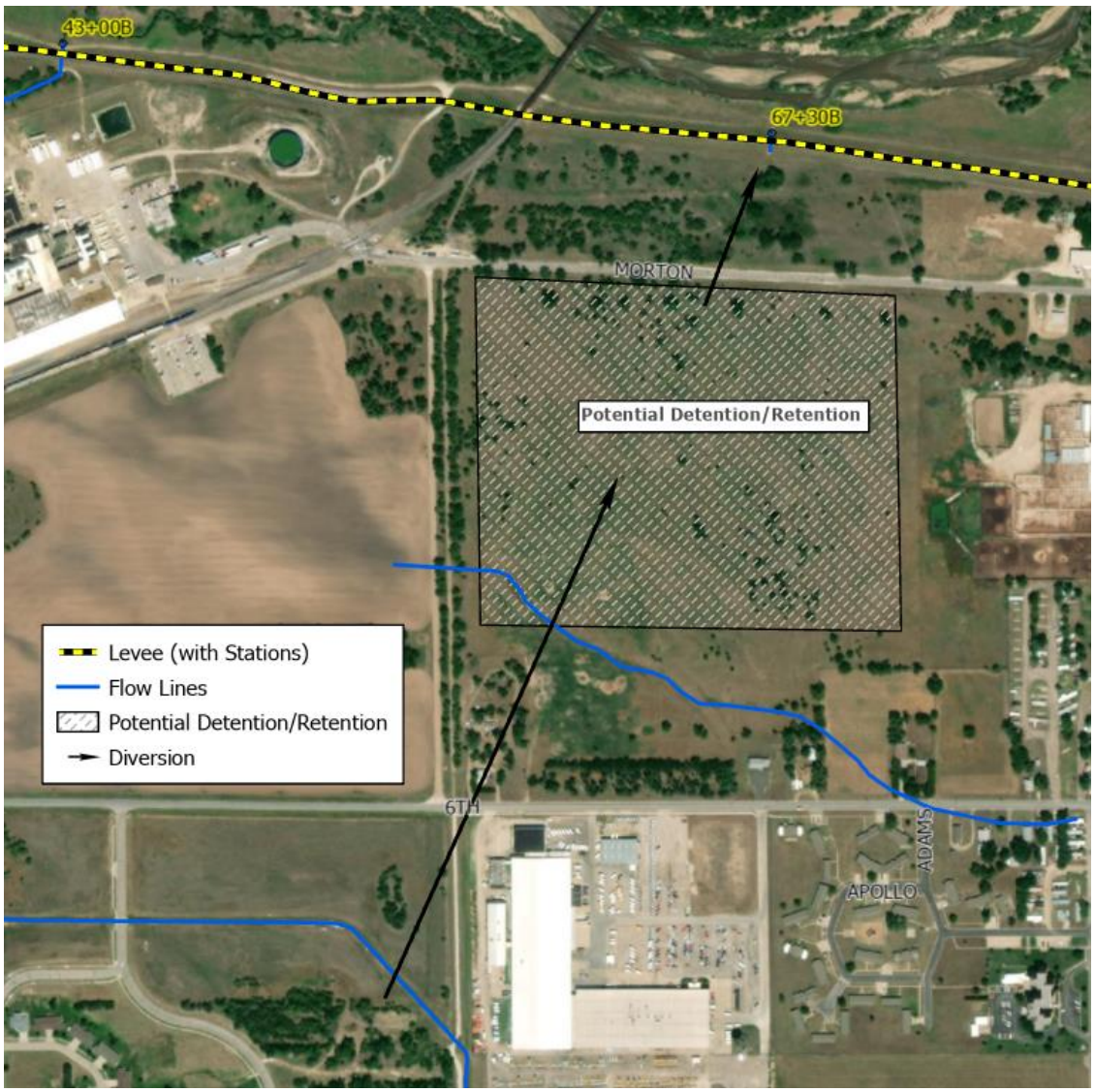


Figure 4-8: Initial concept of diverting water North.

This option was no longer considered when further study of the area revealed that there is not enough elevation grade difference to get water to flow to the north.

4.6.2 Other Detention/Retention Considerations

Several other watershed detention and/or retention areas were also considered as mitigation options. It was determined that some areas, such as those shown in Figure 4-9, should be avoided if possible due to the potential for future development the area. The proposed detention in these areas were limited but the analysis indicated that detention ponds in this area would be effective in reducing downstream impacts. Therefore, limited detention was proposed in some of the conceptual scenarios.

Figure 4-9: Area of potential future development to be avoided by conceptual alternatives.

4.7 Flood Mitigation Options

Cost estimates were not developed for all scenarios. After conversations with KDA and representatives of the City of South Hutchinson, three options were identified as being the most desirable to the community while providing the most beneficial reductions to

the 1% annual chance water surface elevation. Thus, budget level cost estimates were developed for the three options.

4.7.1 Option 1

Option 1 is represented by Scenario 8. This is an independent area that does not influence other areas and is not influenced by any other Scenario. This option includes creating a small storage area adjacent to the levee at levee station 100+30B and increasing the conveyance through the levee at the same levee station. A map of Option 1 with pre- versus post- improvements floodplains and GIS callouts for conduit sizing is in Appendix A. The water surface elevation in this area is reduced by approximately 1.2 feet for the 1% annual chance floodplain.

Option 1 is an isolated independent area. Flooding at this location affects five of the total 197 buildings within the 1% annual chance floodplain. All five of these buildings appear to be commercial. Option 1 would remove all five of these buildings from the 1% annual chance floodplain.

4.7.2 Option 2

Option 2 is represented by Scenario 14. This scenario solves nearly all flooding concerns outlined in this report. This option considers four upstream retention/detention structures allowing for better control of the headwater floodplain, but also adds downstream storage adjacent to the levee near levee station 155+15B. A map of Option 2 with pre- versus post- improvements floodplains and GIS callouts for conduit sizing is in Appendix A. The reduction to the 1% annual chance water surface elevations are tabulated in Table 4-3.

Table 4-3: Water surface Elevation Comparison – Option 2.

	1 % Annual Chance Water Surface Elevation (Feet above Sea Level)	
	Levee Station 155+15B	Levee Station 145+15B
Existing Conditions	1525.6	1525.5
Scenario 14	1522.6	1523.5

Option 2 results in the lowest water surface elevation for the 1% annual chance event. Of the 197 total buildings affected by the 1% annual chance floodplain for South Hutchinson, 192 are in the area that Option 2 attempts to mitigate. Option 2 removes 191 of these

buildings from the 1% annual chance floodplain. Nearly all buildings removed are single family residences.

Unlike Option 3, this option also considerably reduces headwater flooding and a negligible amount of water overtops the roadway at S Washington Street and W Avenue B during the 1% annual chance storm event.

4.7.3 Option 3

Option 3 is represented by Scenario 16. Scenario 16 increases conveyance through the levee at both levee stations 155+15B and 145+15B. Scenario 16 also considers retention/detention adjacent to the levee allowing water to be stored southeast of the railroad near levee station 155+15B. This scenario does not address headwater concerns, but significantly reduces the 1% annual chance water surface elevations adjacent to the levee, which are tabulated in Table 4-4. A map of Option 3 with pre- versus post-improvements floodplains and GIS callouts for conduit sizing is in Appendix A.

Table 4-4: Water Surface Elevation Comparison – Option 3.

	1 % Annual Chance Water Surface Elevation (Feet above Sea Level)	
	Levee Station 155+15B	Levee Station 145+15B
Existing Conditions	1525.6	1525.6
Scenario 16	1522.3	1524.5

Of the 197 total buildings affected by the 1% annual chance floodplain for South Hutchinson, 192 are in the area that Option 3 attempts to mitigate. Option 3 removes 189 of these buildings from the 1% annual chance floodplain. Nearly all buildings removed are single family residences.

Option 3 does not offer any upstream detention/retention and does result in water overtopping roadways during the 1% annual chance storm event, especially at W Avenue B and S Washington Street. Albeit not mapped based on FEMA mapping requirements, this flood risk should be noted by the City of South Hutchinson.

4.7.4 Option 4

Option 4 considers doing nothing. This option makes no improvements to the watershed. The buildings residing in the 1% annual chance floodplain would remain and headwater flooding would continue to be a potential risk.

4.7.5 Option 5

Option 5 considers buying out inundated properties. This option would reduce the number of buildings in the 1% annual chance floodplain, but at significant cost to the City of South Hutchinson.

4.7.6 Option Considerations

The scenarios described in this report are not the only options that could be considered, but these are the options that achieve the best reduction to the number of buildings impacted by the 1% annual chance floodplain and give the City of South Hutchinson multiple perspectives on addressing these flooding concerns. A combination of these options or parts of a single option may be the best course of action, and it is up to the City of South Hutchinson to determine which of these options to pursue, if any.

Pumps should be considered with any option listed. The three options described have potential to remove a significant number of buildings from the mapped 1% annual chance floodplain, but different combinations of interior and riverine conditions could limit the ability of the levee outfall locations to move water out of the interior system. Portable pumps are a mitigation option that should be considered irrespective of any other flood mitigation option. Consideration of a pumping stations with sufficient capacity to convey the 1% annual chance event was considered but ultimately deemed cost prohibitive.

Removal of these buildings from the 1% annual chance floodplain would, based on today's requirements, alleviate the requirement to purchase flood insurance, but these individuals should still consider flood insurance given the inherent flood risk directly adjacent to a levee system. Should the City of South Hutchinson pursue and construct flood mitigation improvements, the cost of flood insurance could be significantly reduced due to the buildings no longer being within the 1% annual chance floodplain based on current flood insurance policies and requirements, as a comparatively-cheaper Preferred Risk Policy rate could be obtained

5.0 Conceptual Cost Estimates

Summarized in Table 5-1 are the budget level cost estimates developed for the three cost options described in the previous section.

The opinion of total project cost includes construction cost, contingency cost, and project cost (including legal, fiscal, financing, engineering design, construction administration, inspection, and staking).

Capital costs have been compiled from manufacturer's data and construction bid tabulations from other similar projects. These values include the cost of materials, tools and equipment necessary for construction and installation. Allowances based upon a percentage of the total capital or specific defined portions of the capital work have been used for certain aspects of the work that are not yet well defined. This level of costing is consistent with industry standards and contains a contingency to cover unforeseen items that will develop during the engineering phase of the project.

Table 5-1: Budget level cost estimates for the three main options.

	Preliminary Construction Estimate	Contingency (30%)	Project Costs (30%)	**Total Project Probable Cost**
Option 1	$ 329,400	$ 98,820	$ 98,820	**$ 527,040**
Option 2	$ 9,510,500	$ 2,853,150	$ 2,853,150	**$ 15,216,800**
Option 3	$ 2,144,000	$ 643,200	$ 643,200	**$ 3,430,400**

A full itemized breakdown for each of these options is listed in Appendix B.

6.0 Summary and Conclusion

The purpose of this project is to investigate and present flood mitigation alternatives to the Kansas Department of Agriculture and the City of South Hutchinson that address flood risk for the mapped 1% annual chance event set to go effective January 29th, 2021.

Sixteen alternative scenarios were modeled and ultimately three of those scenarios were chosen as feasible options for budget level cost estimating. It is noted that Option 1 could be added to either Option 2 or Option 3, but Option 1 should not be considered an alternative to Option 2 or Option 3. A summary of those costs and options is shown in Table 6-1.

Table 6-1: Summary of improvements and estimated budget level costs

	Summary of Improvements	Total Probably Cost
Option 1	Detention at the levee and increased conveyance through the levee at levee station 100+30B	$527,040
Option 2	Five detention ponds inside the levee along with improved conveyance through the levee at 145+15B and 155+15B	$15,216,800
Option 3	Detention at the levee and increased conveyance through the levee at levee station 145+15B and 155+15B	$3,430,400

Making no structural improvements and buying out inundated buildings was also considered. This option would reduce flood risk by physically removing homes from the 1% annual chance floodplain and thus reducing the requirement for those people to carry flood insurance. Buying these buildings out and relocating the residents would be very costly to the City of South Hutchinson. In addition, this could have negative emotional impacts on the residents of town and could hinder future growth opportunities.

Options exist that could allow for the removal of nearly all buildings from the 1% annual chance floodplain. These buildings are mostly single-family residences and if these buildings are successfully shown to be outside of the 1% annual chance floodplain could take away the requirement to purchase flood insurance. These residents should still consider purchasing flood insurance, which could be purchased at a comparatively-cheaper Preferred Risk Policy rate when located outside of the 1% annual chance floodplain. The number of buildings in the 1% annual chance floodplain for existing conditions and proposed conditions is shown in Table 6-2.

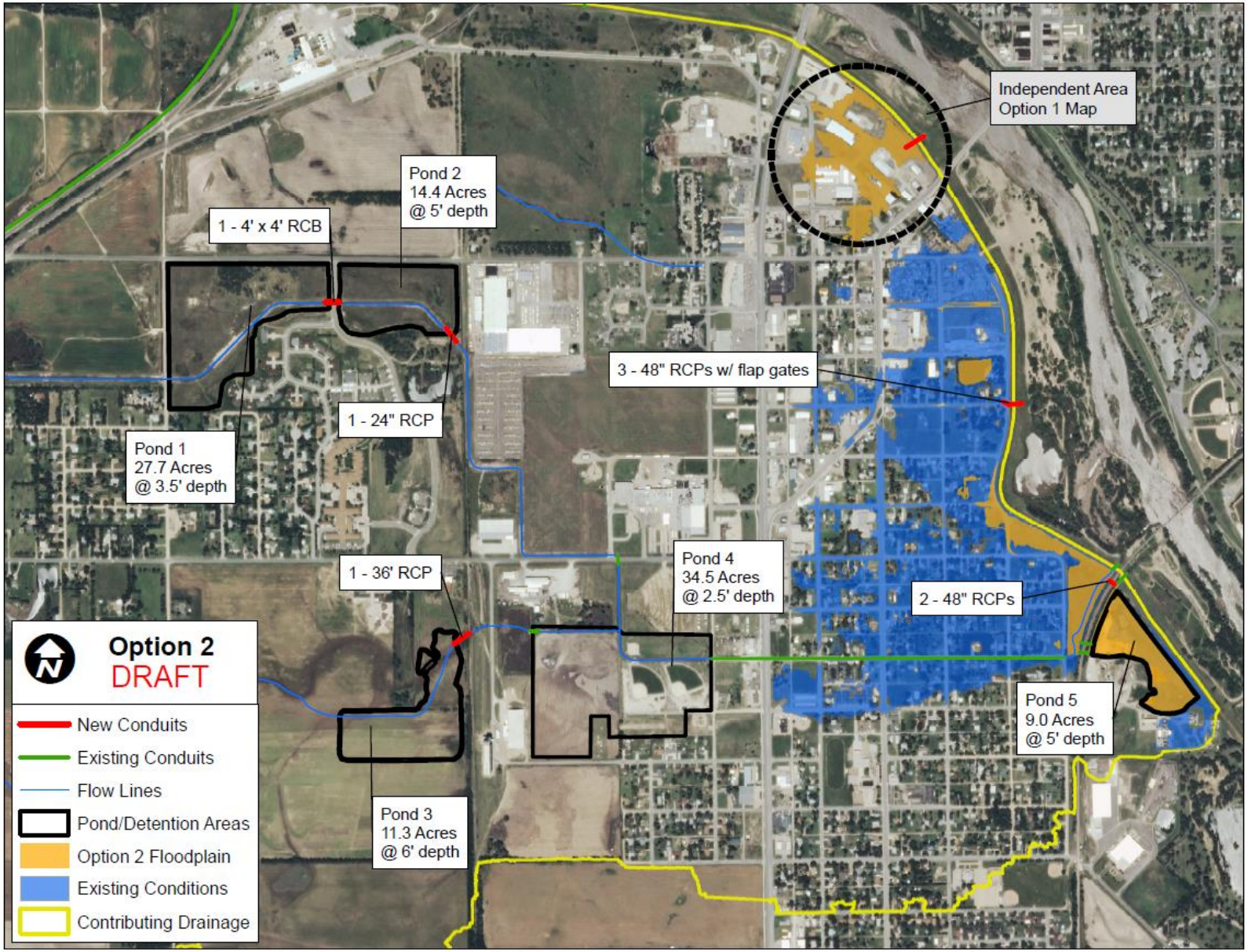
Table 6-2: Number of buildings in the 1% annual chance floodplain

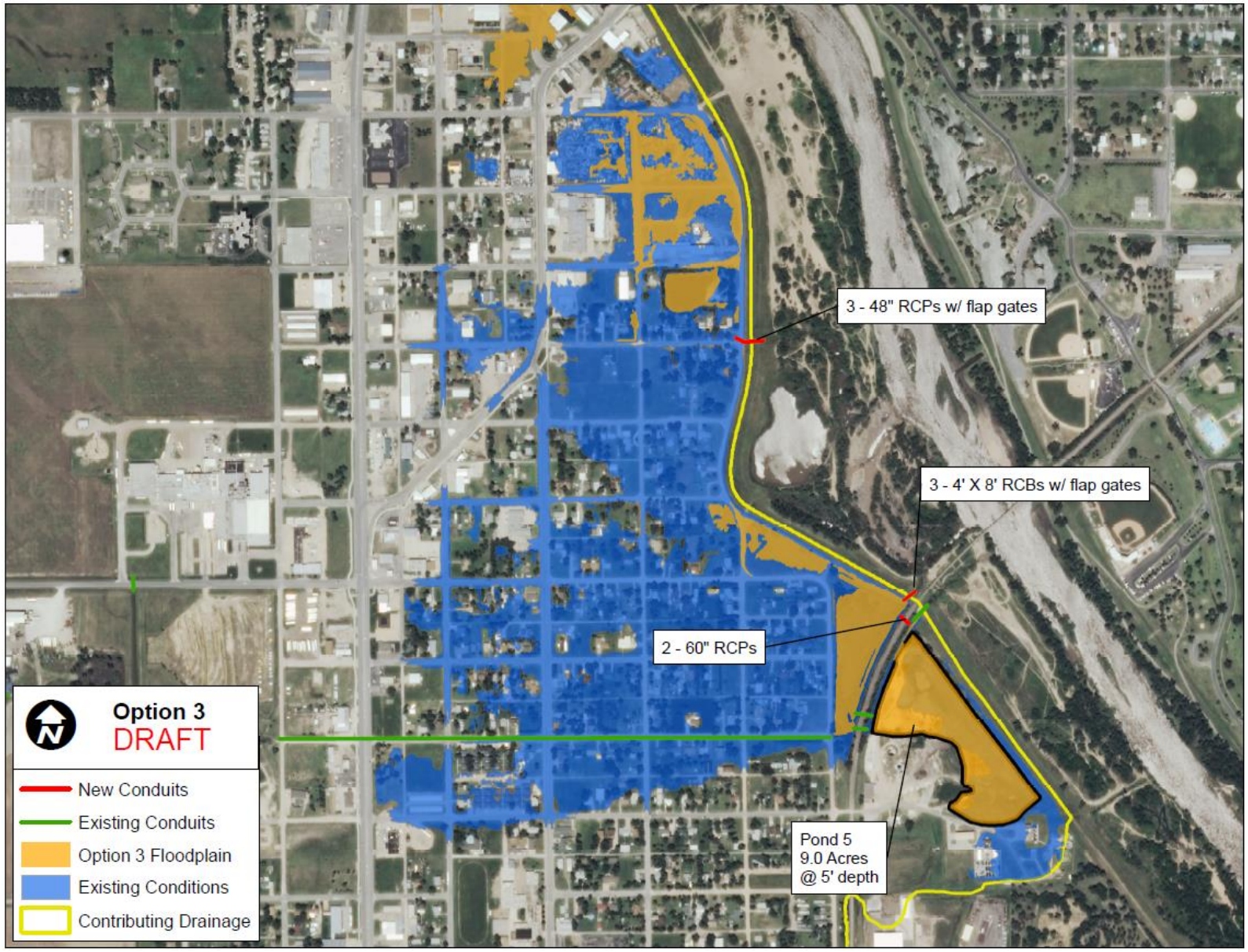
	Existing Conditions	Proposed Conditions
Option 1	5	0
Option 2	192	1
Option 3	192	3

Ultimately, it is up the City of South Hutchinson to determine whether to pursue a Mitigation option, keeping the City's specific needs, concerns, and budgetary requirements in mind.

Appendix A:Floodplain Maps with GIS callouts


Morton Dr
Woody Seat Fwy
W 10th Ave
N Main St
E 8th Ave
E 10th Ave
N Poplar St
N Walnut St
E 7th Ave
Kansas Ave
2 - 48" RCPs w/ flap gates
Pond 6
1.8 Acres
@ 2' depth
Option 1
DRAFT
New Conduits
Pond/Detention Areas
Option 1 Floodplain
Existing Conditions
Contributing Drainage


Independent Area
Option 1 Map
Pond 2
14.4 Acres
@ 5' depth
1 - 4' x 4' RCB
3 - 48" RCPs w/ flap gates
1 - 24" RCP
Pond 1
27.7 Acres
@ 3.5' depth
Pond 4
34.5 Acres
@ 2.5' depth
1 - 36' RCP
2 - 48" RCPs
Pond 5
9.0 Acres
@ 5' depth
Option 2
DRAFT
New Conduits
Existing Conduits
Flow Lines
Pond/Detention Areas
Option 2 Floodplain
Existing Conditions
Contributing Drainage
Pond 3
11.3 Acres
@ 6' depth


3 - 48" RCPs w/ flap gates
3 - 4' X 8' RCBs w/ flap gates
2 - 60" RCPs
Pond 5
9.0 Acres
@ 5' depth
Option 3
DRAFT
New Conduits
Existing Conduits
Option 3 Floodplain
Existing Conditions
Contributing Drainage

Appendix B:Cost Estimate Breakouts

OPTION 1

1 Improve Conveyance and Add Storage at 100+30B				
	Description	**Quantity**	**Unit**	**Unit Costs**	**Total Costs**
	Pond 6 - 1.8 Acres of Unclassified Excavation	5,800	CY	$13	$75,400
	48" RCP	145	LF	$600	$87,000
	Concrete Headwall for Flap Gate	1	EA	$20,000	$20,000
	48" Flap Gate	2	EA	$8,000	$16,000
	RCP End Sections	2	EA	$2,500	$5,000
	Utility Conflict Resolution	1	LS	$70,000	$70,000
	Traffic Control	1	LS	$6,000	$6,000
	Site Clearing and Restoration	1	LS	$50,000	$50,000
PRELIMINARY COSTRUCTION ESTIMATE					**$329,400**
Contingency @ 30%					$98,820
Project Costs @ 30%					$98,820
TOTAL PROJECT PROBABLE COSTS					**$527,040**

OPTION 2

1. Pond 1 and Pond 2				
	Description	**Quantity**	**Unit**	**Unit Costs**	**Total Costs**
	Pond 1 - 27.7 Acres of Unclassified Excavation	156,500	CY	$13	$2,034,500
	4' x 4' RCB	45	LF	$1,000	$45,000
	Concrete Headwall for RCB	2	EA	$15,000	$30,000
	Pond 2 - 14.4 Acres of Unclassified Excavation	116,000	CY	$13	$1,508,000
	24" RCP	40	LF	$240	$9,600
	RCP End Sections	2	EA	$2,500	$5,000
	Remove and Replace Pavement	45	LF	$200	$9,000
	Utility Conflict Resolution	1	LS	$280,000	$280,000
	Traffic Control	1	LS	$6,000	$6,000
	Site Clearing and Restoration	1	LS	$100,000	$100,000
PRELIMINARY COSTRUCTION ESTIMATE					**$4,027,100**
Contingency @ 30%					$1,208,130
Project Costs @ 30%					$1,208,130
TOTAL PROJECT PROBABLE COSTS					**$6,443,360**

2. Pond 3				
	Description	**Quantity**	**Unit**	**Unit Costs**	**Total Costs**
	Pond 3 - 11.3 Acres of Unclassified Excavation	109,500	CY	$13	$1,423,500
	36" RCP	120	LF	$320	$38,400
	RCP End Sections	2	EA	$2,500	$5,000
	Utility Conflict Resolution	1	LS	$140,000	$140,000
	Traffic Control	1	LS	$6,000	$6,000
	Site Clearing and Restoration	1	LS	$50,000	$50,000
PRELIMINARY COSTRUCTION ESTIMATE					**$1,662,900**
Contingency @ 30%					$498,870
Project Costs @ 30%					$498,870
TOTAL PROJECT PROBABLE COSTS					**$2,660,640**

3. Pond 4				
Description	**Quantity**	**Unit**	**Unit Costs**	**Total Costs**
Pond 4 - 34.5 Acres of Unclassified Excavation	139,000	CY	$13	$1,807,000
Utility Conflict Resolution	1	LS	$210,000	$210,000
Traffic Control	1	LS	$6,000	$6,000
Site Clearing and Restoration	1	LS	$50,000	$50,000
PRELIMINARY COSTRUCTION ESTIMATE				**$2,073,000**
Contingency @ 30%				$621,900
Project Costs @ 30%				$621,900
TOTAL PROJECT PROBABLE COSTS				**$3,316,800**

4. Pond 5				
Description	**Quantity**	**Unit**	**Unit Costs**	**Total Costs**
Pond 5 - 9.0 Acres of Unclassified Excavation	29,000	CY	$13	$377,000
Bore & Jack Railroad Crossing	200	LF	$2,200	$440,000
48" RCP	200	LF	$600	$120,000
RCP End Sections	4	EA	$2,500	$10,000
Utility Conflict Resolution	1	LS	$280,000	$280,000
Traffic Control	1	LS	$6,000	$6,000
Site Clearing and Restoration	1	LS	$75,000	$75,000
PRELIMINARY COSTRUCTION ESTIMATE				**$1,308,000**
Contingency @ 30%				$392,400
Project Costs @ 30%				$392,400
TOTAL PROJECT PROBABLE COSTS				**$2,092,800**

6. Increase Conveyance at 145+15B				
Description	**Quantity**	**Unit**	**Unit Costs**	**Total Costs**
48" RCP	445	LF	$600	$267,000
RCP End Sections	3	EA	$2,500	$7,500
Concrete Headwall for Flap Gate	1	EA	$20,000	$20,000
48" Flap Gate	3	EA	$8,000	$24,000
Remove and Replace Pavement	100	LF	$200	$20,000
Utility Conflict Resolution	1	LS	$70,000	$70,000
Traffic Control	1	LS	$6,000	$6,000
Site Clearing and Restoration	1	LS	$25,000	$25,000
PRELIMINARY COSTRUCTION ESTIMATE				**$439,500**
Contingency @ 30%				$131,850
Project Costs @ 30%				$131,850
TOTAL PROJECT PROBABLE COSTS				**$703,200**

OPTION 3

1 Increased Conveyance at 155+15B and Pond Southeast of Railroad				
Description	**Quantity**	**Unit**	**Unit Costs**	**Total Costs**
8' X 4' RCB	210	LF	$650	$136,500
Concrete Headwall for RCB	2	EA	$75,000	$150,000
8' X 4' Flap Gates	3	EA	$40,000	$120,000
Pond 5 - 9.0 Acres of Unclassified Excavation	29,000	CY	$13	$377,000
Bore & Jack Railroad Crossing 60" RCP	200	LF	$2,500	$500,000
RCP End Sections	4	EA	$2,500	$10,000
Utility Conflict Resolution	1	LS	$280,000	$280,000
Levee Repair	1	LS	$50,000	$50,000
Traffic Control	1	LS	$6,000	$6,000
Site Clearing and Restoration	1	LS	$75,000	$75,000
PRELIMINARY COSTRUCTION ESTIMATE				**$1,704,500**
Contingency @ 30%				$511,350
Project Costs @ 30%				$511,350
TOTAL PROJECT PROBABLE COSTS				**$2,727,200**

2 Increase Conveyance at 145+15B				
Description	**Quantity**	**Unit**	**Unit Costs**	**Total Costs**
48" RCP	445	LF	$600	$267,000
RCP End Sections	3	EA	$2,500	$7,500
Concrete Headwall for Flap Gate	1	EA	$20,000	$20,000
48" Flap Gate	3	EA	$8,000	$24,000
Remove and Replace Pavement	100	LF	$200	$20,000
Utility Conflict Resolution	1	LS	$70,000	$70,000
Traffic Control	1	LS	$6,000	$6,000
Site Clearing and Restoration	1	LS	$25,000	$25,000
PRELIMINARY COSTRUCTION ESTIMATE				**$439,500**
Contingency @ 30%				$131,850
Project Costs @ 30%				$131,850
TOTAL PROJECT PROBABLE COSTS				**$703,200**